Fast inverse planning

Fast inverse planning is a technique used in radiation therapy to optimize the delivery of radiation to a tumor while minimizing the dose to surrounding healthy tissues. In this technique, the treatment planning process is automated, and the optimal radiation dose is calculated using computer algorithms.

The goal of fast inverse planning is to reduce the time required to develop a treatment plan, as traditional treatment planning can be a time-consuming process. With this technique, treatment plans can be developed in a matter of minutes, compared to several hours required for traditional planning.

Fast inverse planning algorithms use mathematical models to predict the behavior of radiation in the body and calculate the optimal dose distribution to target the tumor while minimizing the dose to surrounding healthy tissues. These algorithms take into account the size, shape, and location of the tumor, as well as the patient's anatomy and medical history.

One of the advantages of fast inverse planning is that it can be used to develop highly customized treatment plans that are tailored to the specific needs of each patient. This can result in better treatment outcomes and fewer side effects.

However, it is important to note that fast inverse planning is still a relatively new technique, and its effectiveness compared to traditional treatment planning methods is still being evaluated. Additionally, the use of this technique requires specialized software and expertise, which may not be available at all treatment centers.

The objective of the study is to evaluate the user-defined optimization settings in the Fast Inverse Planning (FIP) optimizer in Leksell GammaPlan® and determine the parameters that result in the best stereotactic radiosurgery (SRS) plan quality for brain metastases, benign tumors, and arteriovenous malformations (AVMs).

Methods: Thirty patients with metastases and 30 with benign lesions-vestibular schwannoma, AVMs, pituitary neuroendocrine tumor, and meningioma-treated with SRS were evaluated. Each target was planned by varying the low dose (LD) and beam-on-time (BOT) penalties in increments of 0.1, from 0 to 1. The following plan quality metrics were recorded for each plan: Paddick conformity index (PCI), gradient index (GI), BOT, and maximum organ-at-risk (OAR) doses. A novel objective score matrix was calculated for each target using a linearly weighted combination of the aforementioned metrics. A histogram of optimal solutions containing the five best scores was extracted.

Results: A total of 7260 plans were analyzed with 121 plans per patient for the range of LD/BOT penalties. The ranges of PCI, GI, and BOT across all metastatic lesions were 0.58-0.97, 2.1-3.8, and 8.8-238 min, respectively, and were 0.13-0.97, 2.1-3.8, and 8.8-238 min, respectively, for benign lesions. The objective score matrix showed unique optimal solutions for metastatic lesions and benign lesions. Additionally, the plan metrics of the optimal solutions were significantly improved compared to the clinical plans for metastatic lesions with equivalent metrics for all other cases.

Conclusion: In this study, FIP optimizer was evaluated to determine the optimal solution space to maximize PCI and minimize GI, BOT and OAR doses simultaneously for single metastatic/benign/non-neoplastic targets. The optimal solution chart was determined using a novel objective score which provides novice and expert planners a roadmap to generate the most optimal plans efficiently using FIP. [1].

[1]

Tolakanahalli R, Wieczorek DJJ, Lee YC, Tom MC, Hall MD, McDermott MW, Mehta MP, Kotecha R, Gutierrez AN. OptImal Gamma kNife lIghTnIng sOlutioN (IGNITION) score to characterize the solution space of the Gamma Knife FIP optimizer for stereotactic radiosurgery. J Appl Clin Med Phys. 2023 Mar 1:e13936. doi: 10.1002/acm2.13936. Epub ahead of print. PMID: 36855958.